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# ENTO 401: Insect Physiology—A Peer Review of Teaching Project Benchmark Portfolio

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ENTO 401: Insect Physiology  
Peer Review of Teaching Benchmark Portfolio  
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## **Objectives for the portfolio**

This portfolio documents my efforts to improve the course as I teach it for the second time. My intention was to use the development of a portfolio as a vehicle to modify the course so that the methods I use are better aligned to my overall goals for the course. Consequently, I have produced a portfolio that is directed toward my efforts to develop a more varied approach that improves integrated understanding and scientific thinking and to better document that the development of integrated understanding and scientific thinking have occurred.

I also plan to use the portfolio to better document my efforts in teaching to my college administrators, department head and P & T committee. As a junior faculty member with an 80% research, 20% teaching appointment it is easy for my teaching activities to be overshadowed by research, both in my own mind and in the sight of others. This portfolio will be an opportunity to give visibility to my efforts to improve my teaching.

## **Course Description**

### *Overview*

Entomology 401 covers insect physiology: the study of biological functions in insects. The course content covers the major physiological systems in insects, such as nervous, respiratory, digestive and metabolic systems. I taught the class for the first time in spring 2012 and taught it for the second time in spring 2014. The course is an upper-level course and is a required course for the Insect Science degree. The course is not a prerequisite for any other courses.

The course is taught as a mixed undergraduate and graduate class (401/801). To accommodate the needs and expectations of the two different groups of students, the course has a common 3-credit lecture class and a 1-credit graduate only lab class. Because only five graduate students enrolled in the class in 2014, this portfolio will focus on the undergraduate side of the course. The majority of the undergraduate students are Insect Science majors although some are Horticulture majors or Insect Science / Horticulture double majors or Insect Science / Forensic Science double majors. Some of the students that take the course are interested in research careers in academia, government or the agricultural biotechnology industry. Others are aiming for careers that will involve insect management, for example as crop consultants or in the military.

### *Choice of the course for this portfolio*

When I taught this course for the first time in 2012 it was not only my first time teaching the course but also my first time developing and teaching a course. Consequently, my teaching was primarily in “survival mode”. Content was delivered almost entirely via traditional lectures supplemented with textbook reading and assessment relied heavily on two exams. By the end of the course, I had a number of impressions about the outcomes of this approach. Firstly, I noticed that there were students who appeared to be engaged in the class but who did not fare well on the two

exams. Secondly, even among students who were successful at recalling factual information in exams, it was not clear to me how much deeper understanding had developed. As I prepared to teach the course for the second time, I decided that I would try a broader variety of assessment tools to give all students opportunities to demonstrate their understanding of the material. I also decided to begin making some changes to the way I delivered course content in the hope that I could encourage deeper thinking about the material by the students.

### *Goals and objectives*

I have three overall goals for the course:

1. Development of fundamental knowledge: This represents the foundation of the course, without it, students do not have the basis to develop deeper and more integrated understanding. The aim is for students to know what the major physiological systems in insects are and how they work at the level of structure and molecular processes.

2. Development of deeper understanding: With the base of fundamental knowledge in place, my second goal is that students integrate their knowledge into a deeper understanding of insect physiology. There are several specific types of integrated understanding that I hope to achieve. Firstly, although various physiological systems can be studied separately, they interact and integrate into the functioning of the whole organism. Secondly, insects' physiologies adapt them to their environments but also place constraints upon them. Thirdly, insect physiological systems are not "better" or "worse" than their counterparts in other animals but represent different evolutionary solutions to similar needs and challenges. Fourthly, insect physiology impacts other areas of insect biology including ecology, behavior and pest management.

3. Development of scientific thinking: My third goal is to use insect physiology as a vehicle to strengthen student's understanding of the scientific method and their skills in assimilating and presenting scientific information. Physiology is a largely experimental discipline and it lends itself well to exploring the process of hypothesis-driven research. Ideally, I would like to integrate this into the teaching of fundamental knowledge, i.e. how the knowledge was obtained.

The specific learning objectives, given to students in the syllabus ([Appendix A](#)) are:

1. Describe the major physiological processes in insects
2. Describe the mechanisms by which insect physiological systems function
3. Demonstrate understanding of the particular challenges and advantages that insects face and how their physiology is adapted to meet these
4. Relate knowledge of insect physiology to other aspects of insect biology
5. Integrate knowledge of multiple physiological systems into an understanding of the functioning of the whole organism.

## Teaching and assessment methods

### *Lectures*

Lectures were the principal method of introducing students to the factual material presented in the course. Lectures were held in regular class time and lasted about one hour each. I take the view that it is important that students take their own notes during lectures because the act of note-taking helps them to retain information. In an effort to encourage students to make their own notes, I used slides sparingly. I wrote key words and sketched simple diagrams on the whiteboard. Slides were used to present photographs, complex diagrams and other visual information that could not easily be sketched on the whiteboard. Students were able to access copies of the slides in PDF format from the course site on Blackboard.

Lectures primarily addressed objective 1 (fundamental knowledge). I also endeavored to use lectures to address objective 2 (deeper understanding) whenever possible. I mainly addressed deeper understanding by pointing out connections to material covered in previous lectures and asking students to identify similar connections, for example “where have we encountered serine proteases before?”

### *Case studies*

In order to address objectives 2 (deeper understanding) and 3 (scientific thinking) I lead two in-class discussion sessions. The inspiration for these activities came from a discussion with peers about the value of narrative as a teaching tool. Each discussion session considered a body of scientific knowledge built up from multiple experimental studies. The subject of each discussion was related to material that had been already covered in lectures with the hope that the discussions would also reinforce the lectures.

At the start of the class, students were assigned to small groups of four to five individuals. I began the class by giving a short introduction and describing the first experiment or study. I then gave a prompt question, such as “what can you infer from these results” or “what is the next hypothesis you would test” and the students were given a few minutes to discuss in groups. At the end of the short discussion period, each group was asked to summarize their ideas. We then compared the outcomes of the discussions to the conclusions that were drawn and subsequent work that was done in reality. The process of discussion, followed by a comparison to the studies that were really done was repeated as we worked through the full body of knowledge.

### *Reading*

Assigned reading for the class consisted of a few selected review articles that gave additional information about some of the topics covered in lectures. There was no required textbook for the course.

### *Narrated slides with question and answer sessions*

Shortly after the start of the semester, I was obliged to travel overseas for a period of about three weeks at short notice. This necessitated a significant change to my plans to deliver material via in-person lectures. Instead, I provided students with a set of narrated slide shows covering the material I would otherwise have presented in lectures. The slideshows were provided to the students via Blackboard a few days before I had planned to give the corresponding lecture

I was concerned that some students might not give the narrated slideshows their full attention outside of a classroom environment and that others might not study the slideshows until cramming for an exam. In an effort to help students keep up with the slideshows, I scheduled “question and answer” sessions for regular class hours. The question and answer sessions were lead by Laramy Enders, a postdoctoral research associate and Ashley Yates, a graduate student. Dr. Enders and Ms. Yates both work in my research lab and Ms. Yates was also acting as a TA for the graduate-level lab component of the course. In preparation for each session, I provided some discussion-prompt questions to the session leaders. During each session, the session leaders used the questions I had provided and questions they had devised themselves to stimulate discussion about the material covered in the narrated slideshows. Students were encouraged to ask questions about elements of the material that they found unclear.

### *Graded papers*

Students were required to write two short papers. The goal of each paper was to encourage students to develop a deeper understanding of the material, especially to draw connections between material presented in different lectures, and to evaluate the degree to which they had done so. Students were directed to make these connections via the prompt question for the paper. For example, the prompt for Paper 1 was:

*Describe, as fully as possible, the events that occur from a photon being absorbed by a rhodopsin molecule in a retinula cell to the generation of an action potential in an interneuron that synapses with the retinula cell. You should expect to integrate your knowledge from **more than one lecture** in your answer.*

Papers were graded according to a rubric that awarded points for presenting factually accurate information and for demonstrating an integrated understanding of the process or system as a whole. The rubric corresponding to the prompt above is given in [Appendix B1](#).

### *Graded projects*

Students were assigned two projects in which they were required to develop educational or informational material on an aspect of the course material, intended for a non specialist audience. For the first project, students were asked to design a lab for an introductory-level college class, for the second project, they were asked to develop an

informational poster suitable for an audience of the general public, such as visitors to a museum or zoo. The goal was to encourage students to crystallize their understanding of the topic at hand to the point that they could articulate their understanding clearly and concisely.

Each project was accompanied by an in-class discussion session on the day the project was assigned. Students were assigned to small groups of four to five, given the prompt for the project and asked to discuss it for 20-30 minutes. At the end of the discussion period I lead a whole-class discussion in which each group contributed their thoughts on ways to tackle the project. The aim of the discussion exercise was twofold. Firstly, it afforded students an opportunity to strengthen their understanding of the topic at hand by discussing it with their peers. Secondly, it gave me an opportunity to correct any serious misunderstanding about what was expected for the project and to ensure no students were in a position of not knowing how to tackle the project.

To provide even more clarity about my expectations for the projects, each student was provided with a copy of the rubric I used to grade them. An example rubric is included in [Appendix C1](#).

### *Presentations*

At the end of the semester, each student gave a ten minute presentation on a research paper of their choice. The presentations were strongly focused on objective 3 (scientific thinking). Students were asked to present on a hypothesis driven piece of research. I stressed the need for their chosen topic to be hypothesis driven when explaining the presentation assignment in class and also took care to explain what constitutes a hypothesis and where they could find hypothesis driven papers. The importance of the hypothesis was reinforced by providing students with the grading rubric ([Appendix D1](#)) I used for their presentations, in which 20% of the total points available were for identifying and articulating the papers' hypothesis or hypotheses.

Because adequate preparation was essential to a successful presentation, I instituted two measures to encourage students to work steadily on their presentations. Six weeks before the presentations were scheduled, students were required to submit their chosen paper to me for review. This gave me the opportunity to verify that the papers they had chosen were genuinely hypothesis driven and, if not, recommend that they select an alternative. One week before the presentations were scheduled, each student was required to provide a review of one of their peers' presentations. I had several aims for the review process. Firstly, it forced students to prepare their first draft presentation in sufficient time to make corrections and improvements if needed. Secondly, each student received constructive criticism to allow them to improve their presentations. Thirdly, I hoped that the process of critically reviewing the work of another would help students identify aspects of their own presentations that could be improved. The students' reviews were also graded and each student was provided with the rubric used to grade reviews and a guide to producing a constructive review.



### *Midterm and final exams*

In addition to graded coursework, students were assessed with three exams, two midterms and a final. The exams were somewhat cumulative but focused strongly on the material that had not been subject to an exam thus far. The format of the exams was short to medium length answers. The exams primarily assessed students' retention of factual information (objective 1). Short answer questions were intended to survey students' knowledge across the breadth of the material whereas medium answer questions were intended to evaluate thorough knowledge of a specific system or process.

In addition to questions directed at fundamental knowledge, a few questions were included that were intended to assess deeper understanding (objective 2) or scientific thinking (objective 3). The three example questions shown below were designed to address fundamental knowledge, deeper understanding and scientific thinking, in that order:

*Fundamental knowledge:* Give two ways melanization is thought to kill pathogens

*Deeper understanding:* Insects that have ready access to large amounts of water often excrete nitrogenous waste as ammonia. Most terrestrial insects do not excrete ammonia. In what form (i.e. what molecule) do these insects typically excrete nitrogenous waste? What are the main advantages and disadvantages of excreting nitrogen in this form?

*Scientific thinking:* The heat shock protein HSP70 is found in all insects and is important in enabling them to survive high temperatures. Recently a group of researchers identified the gene that encodes HSP70 in the house fly, *Musca domestica*. They injected flies with double stranded RNA (dsRNA) corresponding to the HSP70 gene. They found that the flies were much more easily killed by bacterial infections than control flies that were injected with a solution that did not contain HSP70 dsRNA.

What was the likely effect of injecting dsRNA on the HSP70 gene in the flies and what does this result tell us about the role of HSP70?

## Analysis of student learning

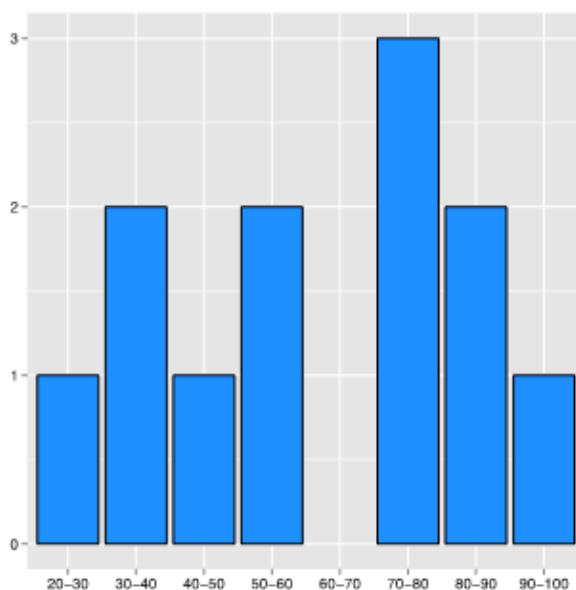
### *Issues early in the semester*

Due to an unavoidable absence of several weeks early in the semester, I delivered part the course via an ad-hoc form of “flipped” classroom. Students were provided with narrated slide shows ahead of the scheduled class time. Areas of confusion were addressed during in-class question and answer sessions lead by a postdoc and a graduate student.

Shortly after my return to Lincoln, the students were given their first midterm exam and their first paper assignment. The results of these assessments made it clear that, although necessary, the narrated slide show plus question and answer session approach had left significant numbers of students struggling to cope with the course. The distribution of percentage scores for the midterm (Figure 1) revealed that half the class fared extremely poorly (<60%) while the other half had good or at least acceptable scores (> 70%). When students submitted their first paper, it was immediately apparent that many of them had not followed the direction that they should include material presented in more than one lecture (see above) and instead focused on information from a single lecture. To remedy the problem, I gave the class some additional coaching on the paper assignment in class and gave them an opportunity to submit a revised paper. The revised papers showed a substantial improvement with the majority of students at least attempting to address the prompt in full. The results of both the midterm and the first paper made it clear that about half the class had not been able to keep up or stay engaged during my absence.

Because of the anomalous nature of the first midterm, it will not be included in the analysis of student learning.

*Figure 1. Distribution of student scores on first midterm*



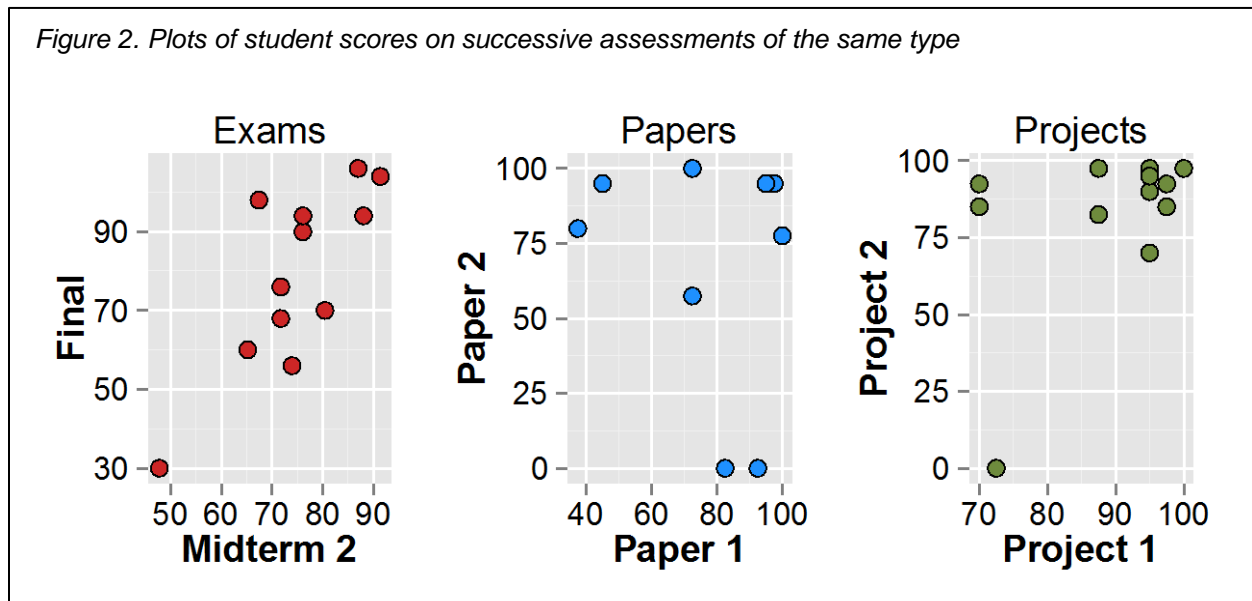
## Overview analysis

This section presents a statistical analysis of some general trends in students' scores on exams and assignments. I chose to focus on exams, papers and projects because in each case, students were given two assessments of the same type. In all cases, student scores are given as percentages which were not normally-distributed so nonparametric methods were used.

Wilcoxon signed rank tests with paired samples were used to test if student scores changed significantly over time for each type of assessment. Comparisons were between the second midterm and final exam, the first and second paper assignments, and the first and second project assignments. In no case did student scores change significantly between two assessments of the same type. The p-values for the comparisons of exams, papers and projects were 0.34, 0.45 and 0.48 respectively.

To understand the relationship between student scores in successive assessments in more detail, the correlation between students scores was tested using Spearman rank tests. there was a significant correlation between students scores on the second midterm and the final exam ( $\rho = 0.66$ ,  $p = 0.02$ ), indicating that students that did well on the midterm tended to do well on the final but also, disappointingly, that students that did poorly on the midterm did not tend to improve a great deal on the final. There was no significant correlation between students' scores on the first and second papers ( $\rho = 0.11$ ,  $p = 0.73$ ) or the first and second projects ( $\rho = 0.33$ ,  $p = 0.30$ ). Plots of student scores for successive assessments (Figure 2) suggested two reasons why scores were not correlated for papers and projects. Unfortunately, one or two students did not submit the second paper or project and so received a score of zero. More encouragingly, a couple of students who fared relatively poorly on the first paper or project improved substantially on the second paper or project.

Figure 2. Plots of student scores on successive assessments of the same type



## Focused Analysis

This section presents analyses of selected assignments and exam questions in the context of the three goals for the course (fundamental knowledge, deeper understanding, scientific thinking). Student performance on assignments will be summarized by the categories “Basic”, “Intermediate” and “Advanced”, corresponding to scores of  $\leq 70\%$ ,  $70 - 85\%$  and  $\leq 85\%$ , respectively.

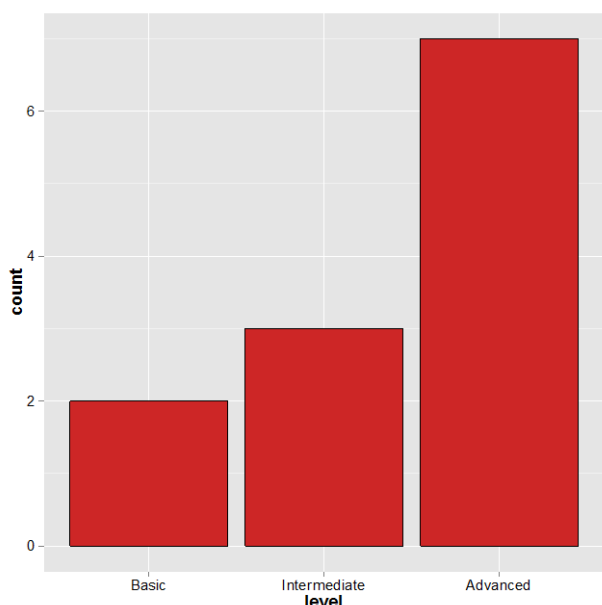
An example paper: Students were asked to write a paper of up to 1,500 words with the following prompt:

*Describe, as fully as possible, the events that occur from a photon being absorbed by a rhodopsin molecule in a retinula cell to the generation of an action potential in an interneuron that synapses with the retinula cell. You should expect to integrate your knowledge from **more than one lecture** in your answer.*

A grading rubric ([Appendix B1](#)) was used to assign points out of 20, which were then converted to percentages. The paper addressed goals 1 and 2 (fundamental knowledge, deeper understanding). Points were awarded for accurately describing three major processes that had been covered in different lectures and for showing the connection between each process.

The distribution of student performance is shown in Figure 3. The overall distribution was encouraging, over half the students demonstrated an advanced level of performance and only two students out of 12 demonstrated a basic level of performance.

Figure 3. Student performance distribution for paper 1



An example of student work at the basic level, along with my evaluation is given in [Appendix B2](#). An example of work at the advanced level is given in [Appendix B3](#). The basic paper focused almost entirely on material that was presented in a single lecture. Other important processes were mentioned but were not described in any detail and the connections between process were not articulated. The advanced paper gave a full description of each major process covered by the prompt and showed clearly how the processes related to each other.

Overall, the paper assignment was effective in enabling students to demonstrate their knowledge of

different mechanisms involved in insect vision and their understanding of how these mechanisms interact.

An example project: Students were asked to design an introductory-level lab class and given the following prompt:

**Task:** Design a lab for a 100-level class that illustrates an aspect of the endocrine system's role in regulating insect development. If necessary, your lab may extend over more than one class period (e.g. set up one week, collect results in a different week). Write a short document (1,000 words maximum) describing your lab. Your document should include.

- An explanation of the effect of the endocrine system that your lab illustrates.
- A description of the procedures to be used in the lab
- The expected results and an explanation of how these results illustrate the effect of interest.

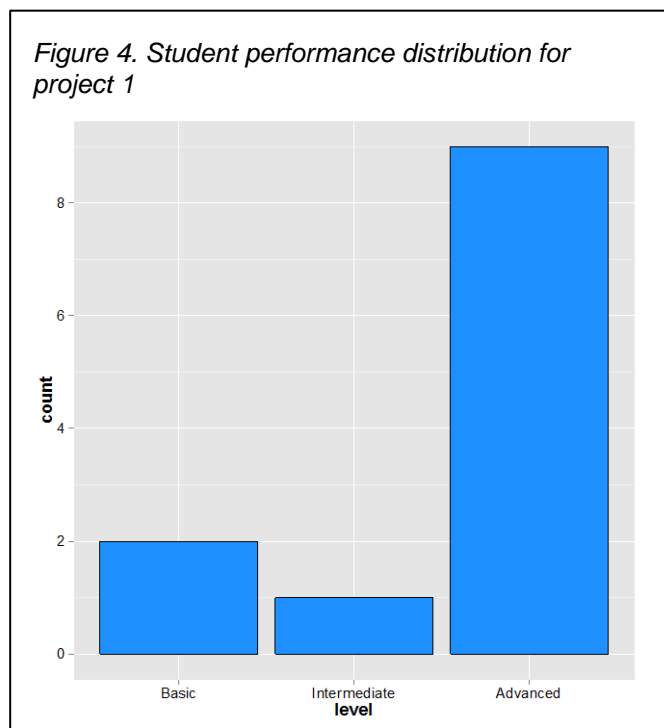
Keep in mind that the procedures for the lab should be appropriate for the skills that could be reasonably be expected of undergraduates taking a 100-level class and the resources that would be available to such a class.

In addition to the information in the prompt, an in-class discussion session was held to help students develop ideas for potential lab classes.

The project addressed all three goals for the course. Students demonstrated their level of fundamental knowledge by writing an explanation of the system illustrated by their lab. Students showed their level of deeper understanding by their ability to design an effective lab that required thinking about a physiological system in the context of a whole organism. Finally, students demonstrated their level of scientific thinking through their ability to design a lab that directly demonstrated the process in question and was not confounded by other phenomena that could affect the results.

Projects were evaluated using a rubric ([Appendix C1](#)) that awarded points for accurately explaining the physiological process that the lab was intended to illustrate and for designing a lab that would be feasible, effective and for which the results could be clearly related to the principle to be illustrated. The distribution of student performance is shown in Figure 4. A substantial majority of students (9/12) demonstrated an advanced level of performance on the assignment.

An example of a student work demonstrating a basic level of performance is given in [Appendix C2](#). This work demonstrates a degree of basic fundamental knowledge but a lack of deeper understanding. The work demonstrates knowledge of the hormones involved but confuses their roles: "*if another hormone, ecdysone, reaches a critical concentration, the insect will finally develop into an adult*". The work also demonstrates limited proficiency in scientific thinking, the lab is presented in terms of hormones but operates on anatomical structures so no conclusions about specific hormones could be made from the results of the lab.



**Appendix C3** presents an example of student work at an advanced level of performance. The work contains knowledge beyond the information given in lectures and shows an understanding of the specific effects of juvenile hormone in the study organism: “*application of methoprene should extend the fifth instar*”. The work also demonstrates sophisticated scientific thinking. The lab includes control treatments (solvent with no hormone) and uses measurements (weight) that can differentiate between a prolonged larval stage and a general reduction in developmental rate.

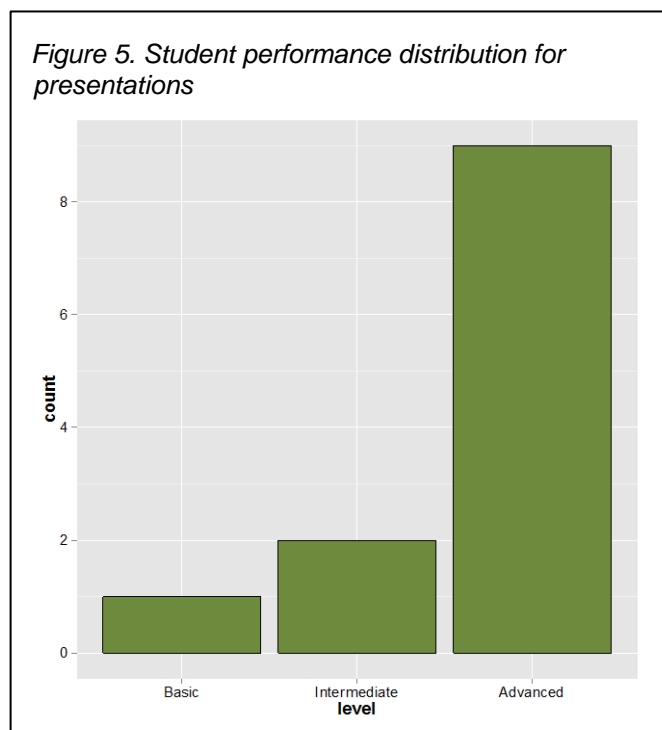
This assignment was developed as a direct result of discussions held as part of the Peer Review of Teaching program. The assignment was effective

in promoting student learning and in enabling students to demonstrate proficiency across all three goals for the course.

**Presentation:** Each student gave a presentation on a scientific paper of their choosing. This assignment focused on goal 3, scientific thinking. Student presentations were graded according to the rubric given in **Appendix D1**. The rubric strongly emphasized students’ ability to identify and articulate a hypothesis that was tested in the paper and their ability to distill the complex information in the paper into concise summaries.

Figure 5 shows the distribution of student performance for presentations. The majority of students (9/12) demonstrated an advanced level of performance. Advanced students were able to summarize the content of their chosen paper and were able to identify and clearly articulate a hypothesis. The few students that demonstrated a basic or intermediate level of performance either did not identify a hypothesis or did not articulate the hypothesis.

**Appendix D2** shows a slide from a



presentation that demonstrated a low intermediate level of performance. The slide is titled “Hypothesis” but does not present a falsifiable hypothesis. The slide presents the motivating question and overall approach of the paper instead of a hypothesis.

**Appendix D3** shows a slide from an advanced level presentation. In this case, a falsifiable hypothesis is presented. Presenting a hypothesis in this manner required a sophisticated reading of the original paper on the part of the student because the paper tested several hypothesis that were not always clearly articulated in the text.

The presentation assignment was coupled with a requirement that students give and receive feedback on each others’ draft presentation. Overall, the process was effective at giving students the opportunity to practice interpreting a primary research paper and to demonstrate their ability to do so.

Selected exam questions: The majority of exam question were directed toward goal 1 (fundamental knowledge), a few questions were directed toward goals 2 and 3 (deeper understanding, scientific thinking). This section presents an analysis of three exam questions, each directed towards a different goal. The distribution of student scores for each question are shown in Figure 6.

The question intended to test fundamental knowledge was:

Give two ways melanization is thought to kill pathogens

The distribution of student scores was somewhat disappointing, with the majority of students (9/12) getting two or fewer of the available four points. The only answer that received full points was “*Melanization is thought to suffocate the pathogen cell. It is also thought this process produces toxic substances, such as hydrogen peroxide, that destroy the pathogen cells*”. Answers that were awarded less than full points typically presented only one or no correct modes of action of melanization. This was not designed to be an especially difficult question, students had been told about four different modes of action during the corresponding lecture, each of which would have been acceptable for the answer.

The question designed to test deeper understanding was:

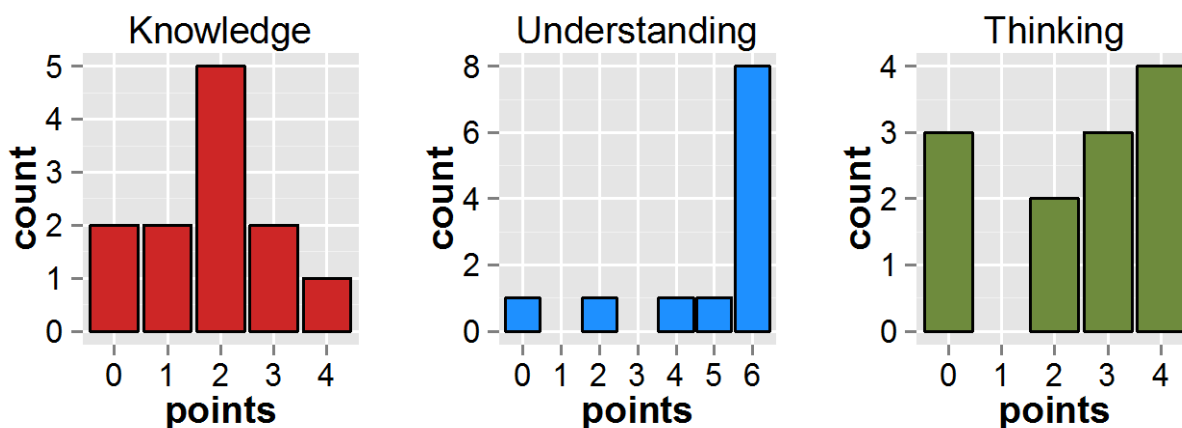
Insects that have ready access to large amounts of water often excrete nitrogenous waste as ammonia. Most terrestrial insects do not excrete ammonia. In what form (i.e. what molecule) do these insects typically excrete nitrogenous waste? What are the main advantages and disadvantages of excreting nitrogen in this form?

The advantages and disadvantages of the excretory molecule in question (uric acid) had been discussed at some length in the corresponding lecture. The distribution of student scores for this question was encouraging, with the majority of answers earning full points. A typical answer was “*Most terrestrial insects excrete nitrogenous waste as uric acid. The advantage of uric acid is that it is less soluble and less toxic than ammonia is. This means that an insect can produce large amounts of uric acid with less of an effect than ammonia... A disadvantage of excreting via uric acid is that it is costly to make and requires a lot more energy to produce than ammonia does.*” It may be



coincidental but this question, in which most students scored highly, related to a lecture in which I spent a significant amount of time discussing why insects use different excretory molecules and comparatively little presenting “hard” facts, such as the synthesis pathways of different molecules.

Figure 6. Distribution of student scores on three exam questions designed to test fundamental knowledge, deeper understanding and scientific thinking



The question designed to test scientific thinking was:

The heat shock protein HSP70 is found in all insects and is important in enabling them to survive high temperatures. Recently a group of researchers identified the gene that encodes HSP70 in the house fly, *Musca domestica*. They injected flies with double stranded RNA (dsRNA) corresponding to the HSP70 gene. They found that the flies were much more easily killed by bacterial infections than control flies that were injected with a solution that did not contain HSP70 dsRNA.

What was the likely effect of injecting dsRNA on the HSP70 gene in the flies and what does this result tell us about the role of HSP70?

The phenomenon of RNA interference (gene suppression by double stranded RNA) and its application as a research tool had been covered in significant detail by a lecture.

The distribution of student scores on this question was disappointing, especially when compared to student performance on assignments related to scientific thinking. Only four students gave answers that earned full points. One answer that earned full points was “*The likely effect of dsRNA being injected on HSP70 gene in flies was the silencing and interference of that gene. The role of HSP70 as a result of the experiment shows evidence supporting the HSP70 is involved in the insect immune system and immune response to bacteria pathogens.*” In this answer, the student not only showed an understanding of the RNA interference phenomenon but also drew a sensible conclusion from result of the experiment. Answers that earned partial points typically suffered from over-interpretation of the experiment’s result.



## *Conclusions*

In general, the results of assignments (papers, projects and the presentation) indicated that most students were able to develop a deep understanding of aspects insect physiology and were able to demonstrate a good or advanced level of scientific thinking. Although assessing the acquisition and retention of fundamental knowledge was not the main focus of most assignments, having such knowledge should be a prerequisite to performing well on a given assignment. Thus, the generally high performance of most students on assignments implies that they had at least a reasonable level of fundamental knowledge about the topic of each assignment.

Because of the small sample size (12 students) statistical analyses of trends in student performance did not have a great deal of power. Nevertheless, some encouraging trends were seen when comparing students' performance on successive assignments of the same type. Setting aside cases where a student did not submit an assignment at all, students who performed well on one assignment generally continued to perform well on the next assignment. Generally, students that performed less well on the first assignment improved their performance on the second assignment. This suggests that students with relatively low performance early in the semester were able to improve their learning or at least their understanding of what was expected of them for assignments as the semester progressed.

Exams were intended to be the principal method of evaluating students' level of fundamental knowledge of insect physiology. Exams were the only form of assessment for which there was a significant correlation in student performance between successive assessments. Students that did well on one exam tended to do well on the next exam, but students that did less well on one exam did not tend to improve their performance on the next exam. One interpretation of this trend is that the exams tended to measure students' ability to prepare for exams rather than their actual level of knowledge of the subject. This interpretation is supported to a degree by an observation that I made during the semester: there were a couple of students that consistently fared poorly in exams but who generally performed very well on other forms of assessment. Overall student performance on selected exam questions aimed at testing fundamental knowledge and scientific thinking did not correspond closely to overall performance on assignments. It would appear that of all the assessment methods used, exams were the least effective at measuring students' progress toward my goals for the course.

## **Planned changes.**

### *Syllabus*

During the writing of this portfolio, it became apparent to me that the connections between my goals for the course and the learning objectives I gave in the syllabus were not explicitly stated. I intend to modify the learning objectives in the syllabus so they are better aligned to my overall goals for the course. To maximize clarity, I will state the three goals of fundamental knowledge, deeper understanding and scientific thinking and associate concrete learning objectives with each goal. For example, two objectives

associated with the goal that students develop fundamental knowledge of insect physiology could be:

1. Students can describe the major physiological processes in insects
2. Students can describe the mechanisms by which insect physiological systems function

### *Exams*

Developing this portfolio has demonstrated to me that the midterm and final exams were less effective and reliable as measures of student learning than I would like them to be. Consequently, I intend to make changes to my use of exams as an assessment tool. At the time of writing, I have not decided exactly what changes I will make, but there are at least three options:

Abandon exams altogether. Other forms of assessment, such as additional papers could be substituted for exams. A possible disadvantage of this approach would be that it would be difficult to survey students' level of fundamental knowledge across the breadth of material covered by the course.

Replace in-class exams with take home tests. Part of my concern about exams is the possibility that they measure students' ability to prepare, study or cram for the exam instead of their level of knowledge and understanding of the course content. It may be possible to remove this effect by switching from timed, closed-book exams held in the classroom to take-home tests. In principle, a take home-test could be closed-book but the extra effort needed to police this could be burdensome. A better option would probably be to have open-book tests but write and grade the questions accordingly.

Modify the exam format. The exams I gave this semester relied on short written answers with one or two questions requiring longer written answers. It might be that including a greater variety of question formats (multiple choice, true/false, matching questions, etc.) would improve the effectiveness of exams.

Developing an alternative to my current exam strategy and evaluating the alternative's effectiveness could be the subject of a future portfolio.

### *Presentation of content*

As I developed this portfolio and taught the class, I became aware that my lectures ranged from being dense with factual information to containing fewer "hard" facts but more discussion of principles, especially what advantages or disadvantages particular physiological mechanisms confer on insects in different circumstances. Although I did not collect any data to evaluate the relative effectiveness of the two approaches, I have the impression that the less facts, more principles approach was better. This is illustrated to some extent by the sample exam question on excretion. Most students performed well on this question and I suspect that this was in part due to the combination of "what" and "why" that characterized both the question and my teaching of the material in question. Before I teach the class again, I plan to revisit the

more fact-heavy lectures and make them more principles-oriented. This may come at the expense of some factual content but hopefully this will be offset by better retention of the information that is presented.

The use of narrated slide shows to convey some of the course material was necessary due to circumstances at the time but produced disappointing results in terms of student learning. I do not plan to repeat the use of narrated slideshows for this course.

### **Reflections on the portfolio process.**

Developing this portfolio and participating in the Peer Review of Teaching program have given me several important insights into my course, the way I teach it and the methods I use to evaluate student learning.

A particularly valuable experience was discussion of potential assignments with colleagues from different disciplines with different perspectives. This greatly improved the quality and usefulness of the assignments I gave students, especially the two projects.

The discipline involved in writing this portfolio and discussing my course with peers have shown me that it is surprisingly easy to lose sight of one's goals for a course in the midst of a busy semester. Participating in the portfolio and peer review process helped me to keep sight of my goals for the class, especially when developing assessment materials.

Collecting evidence of student performance on different assessments and analyzing the data was highly informative. It was surprising to me that for several assessments, my subjective impression of student performance while grading a particular assessment did not always correspond to the findings of a considered analysis.

A particularly useful outcome has been the increased understanding I have gained of the exams I used to evaluate student learning. At the outset of this process, I was concerned about the value of my exams, but was unsure exactly where the problems lay. Developing this portfolio has allowed me clearly identify the areas of concern and potential solutions.

## **Appendices**

<b>A</b>	<b>Syllabus</b>
<b>B1</b>	<b>Grading rubric for paper 1</b>
<b>B2</b>	<b>Example of basic student work for paper 2</b>
<b>B3</b>	<b>Example of advanced student work for paper 2</b>
<b>C1</b>	<b>Grading rubric for project 1</b>
<b>C2</b>	<b>Example of basic student work for project 1</b>
<b>C3</b>	<b>Example of advanced student work for project 1</b>
<b>D1</b>	<b>Grading rubric for presentation</b>
<b>D2</b>	<b>Example of basic student work for presentation</b>
<b>D3</b>	<b>Example of advanced student work for presentation</b>

# Entomology 401: Insect Physiology

## Instructor

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109E Entomology Hall  
University of Nebraska-Lincoln  
Lincoln NE 68583-0816  
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## Office Hours

Mondays 2:30pm to 4:30pm

## Course Description

Physiology is the science of biological functions in living organisms. While many commonalities exist between insect physiology and that of other organisms, there are also many aspects of the physiology of insects that are unique and adapted to their particular way of life. Physiology may conveniently be studied as a set of systems (e.g. the nervous system, digestive system, etc.), which will be the approach taken in this course. Consideration will be given to the ways physiological systems interact with each other in the organism as a whole and with other aspects of insect biology such as behavior and ecology.

## Objectives

By the end of the course, students will be able to:

1. Describe the major physiological processes in insects
2. Describe the mechanisms by which insect physiological systems function
3. Demonstrate understanding of the particular challenges and advantages that insects face and how their physiology is adapted to meet these
4. Relate knowledge of insect physiology to other aspects of insect biology
5. Integrate knowledge of multiple physiological systems into an understanding of the functioning of the whole organism

## Instructional Method

Lectures will be given on Mondays and Wednesdays from 1:00 pm to 2:15 pm. Material presented in the lectures is developed from a variety of sources including various textbooks, review articles and the primary research literature. There is no required course textbook. This means that the lectures will provide a significant amount of information that is not found in any single source and it is imperative that each student attends all lectures and takes good lecture notes.

Material presented in the lectures will be supplemented with readings that will be distributed via the course Blackboard site or from texts that are held on reserve at the C Y Thompson library.

### **Topic Outline**

The following list is provisional and may be modified as appropriate:

- Nervous system
- Sensory systems
- Endocrine system
- Circulatory system
- Immune system
- Integument
- Digestive system
- Excretory system
- Respiratory system
- Metabolism
- Muscles and movement
- Reproductive system
- Development

### **Presentation**

Each student will give a short presentation about a hypothesis-driven research paper from the primary research literature. Subjects must be submitted to the instructor for approval by March 19. Presentations will take place on Monday April 28 and Wednesday April 30. The order of speakers will be random and determined at the start of the April 28 class. Each student will review one other student's draft presentation and provide constructive criticism. A written review, which will be graded, must be submitted to the presenter and via Blackboard to the instructor before the start of class on Monday April 21.

### **Exams**

There will be three exams, two midterms and a final. The exams will be cumulative but will emphasize material covered since the previous exam(s).

### **Papers**

Each student will be required to write two short papers demonstrating their knowledge and understanding of selected topics in insect physiology. Topics and deadlines for papers will be announced, ahead of time, during lecture classes.

## Projects

Each student will complete two short projects. Project 1 is to design a lab class to illustrate a physiological process. Project 2 is to design an informational display suitable for children and the general public that explains an aspect of insect physiology. Both projects must be completed by each student on their own. There will be an opportunity to discuss project ideas in small groups in class on the day that the project topics are announced.

## Grades

Each exam, paper, project and presentation activity will be given a percentage grade. A final percentage grade for the class will be calculated from the weighted percentages of each assessment according to the following scheme:

Midterm 1	13%
Midterm 2	13%
Final	14%
Paper 1	8%
Paper 2	8%
Project 1	12%
Project 2	12%
Review of draft presentation	5%
Presentation	15%

Letter grades will be assigned from the final class percentage grade as follows:

≥ 90%	A
≥ 80%	B
≥ 70%	C
≥ 60%	D
< 60%	F

## Make-up and Extra Credit Policy

No make-up exams will be offered. No extra credit will be available.

## Academic Honesty

The University of Nebraska-Lincoln has a clear policy about academic dishonesty that is described in the Student Code of Conduct. The code can be found in the Undergraduate Bulletin and online at <http://stuafs.unl.edu/ja/code>. As a student at

UNL, you enjoy rights and protections under the code and are obligated to conduct yourself in compliance with the code.

As the Student Code of Conduct indicates, academic sanctions for misconduct subject to appeal are at the discretion of the instructor, and may include giving the student a failing grade for the course. In this course, the least penalty that will be imposed for misconduct is a one letter grade reduction in the course grade, but in most instances the penalty for cheating will be a failing grade in the course.

### **Pledge of Instructional Standards**

Entomology instructors will provide our students a complete syllabus meeting all UNL standards, our classes will be based on current science and will follow published schedules and descriptions, and our instructors will be timely in returning grades and in responding to our students.

### **Peer Review of Teaching Project**

This semester, I have elected to take part in the Peer Review Project, a University-wide, on-going attempt to develop new and better methods for promoting student learning. This is a year-long process in which participants in the project (professors) put a great deal of thought into the design of a single course (in this case ENTO 401/801) including syllabus, exams, class activities and written assignments. One of the project's ultimate goals is to improve student learning, and we cannot accomplish this goal without student input.

For the project, I will need to select several students whose work would be copied and included in my course portfolio as an archive of student performance for the course. These examples are a very important piece of the project for professors to show how much and how deeply students are learning. Once the course portfolio is completed, it will be put on a project website ([www.courseportfolio.org](http://www.courseportfolio.org)) so that it can be shared, used, and reviewed by other faculty.

### **Students with Disabilities**

Students with disabilities are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation. It is the policy of the University of Nebraska-Lincoln to provide flexible and individualized accommodation to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with the Services for Students with Disabilities (SSD) office, 132 Canfield Administration, 472-3787 voice or TTY.



## ENTO 827 Paper 1 Score Sheet

Name:

Total score:

**Question:** Describe, as fully as possible, the events that occur from a photon being absorbed by a rhodopsin molecule in a retinula cell to the generation of an action potential in an interneuron that synapses with the retinula cell. You should expect to integrate your knowledge from **more than one lecture** in your answer.

There are three major process that should be described: the visual cascade, generation and propagation of an action potential and transmission of the nerve signal across a synapse. A successful paper will describe each of these process in detail and demonstrate understanding of the sequence in which they occur and how they are related.

The descriptions of typical answers, given below, are guidelines, not checklists for assigning points

### Visual cascade

*Basic* (1 point) Mentioned but not described

*Intermediate* (3 points) Some details given but others are missing and/or details in incorrect order

*Advanced* (5 points) All steps described in detail and in correct order

### Action Potential

*Basic* (1 point) Mentioned but not described

*Intermediate* (3 points) Some details given but others are missing and/or details in incorrect order

*Advanced* (5 points) All steps described in detail and in correct order

<p><b>Synapse</b></p> <p><i>Basic</i> (1 point) Mentioned but not described</p> <p><i>Intermediate</i> (3 points) Some details given but others are missing and/or details in incorrect order</p> <p><i>Advanced</i> (5 points) All steps described in detail and in correct order</p>	
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<p><b>Sequence of / relationship between major processes</b></p> <p><i>Basic</i> (1 point) Major process mentioned but order incorrect and/or no understanding of relationship</p> <p><i>Intermediate</i> (3 points) Major processes in correct sequence, relationship partially described or some mistakes</p> <p><i>Advanced</i> (5 points) Major process in correct sequence, clear understanding of relationship</p>	
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## ENTO 827 Paper 1 Score Sheet

Name: [REDACTED]

Total score:

7.5/20

**Question:** Describe, as fully as possible, the events that occur from a photon being absorbed by a rhodopsin molecule in a retinula cell to the generation of an action potential in an interneuron that synapses with the retinula cell. You should expect to integrate your knowledge from **more than one lecture** in your answer.

There are three major process that should be described: the visual cascade, generation and propagation of an action potential and transmission of the nerve signal across a synapse. A successful paper will describe each of these process in detail and demonstrate understanding of the sequence in which they occur and how they are related.

The descriptions of typical answers, given below, are guidelines, not checklists for assigning points

<p><b>Visual cascade</b></p> <p><i>Basic</i> (1 point) Mentioned but not described</p> <p><i>Intermediate</i> (3 points) Some details given but others are missing and/or details in incorrect order</p> <p><i>Advanced</i> (5 points) All steps described in detail and in correct order</p>	<p style="text-align: center;">④</p> <p style="color: red;">Some confusion regarding IP3 vs DAG as activator of TRP channels. Otherwise, good</p>
<p><b>Action Potential</b></p> <p><i>Basic</i> (1 point) Mentioned but not described</p> <p><i>Intermediate</i> (3 points) Some details given but others are missing and/or details in incorrect order</p> <p><i>Advanced</i> (5 points) All steps described in detail and in correct order</p>	<p style="text-align: center;">①</p> <p style="color: red;">Mentioned, not described</p>

<p><b>Synapse</b></p> <p><i>Basic</i> (1 point) Mentioned but not described</p> <p><i>Intermediate</i> (3 points) Some details given but others are missing and/or details in incorrect order</p> <p><i>Advanced</i> (5 points) All steps described in detail and in correct order</p>	<p>①</p> <p><i>Mentioned, not described</i></p>
<p><b>Sequence of / relationship between major processes</b></p> <p><i>Basic</i> (1 point) Major process mentioned but order incorrect and/or no understanding of relationship</p> <p><i>Intermediate</i> (3 points) Major processes in correct sequence, relationship partially described or some mistakes</p> <p><i>Advanced</i> (5 points) Major process in correct sequence, clear understanding of relationship</p>	<p>①.5</p> <p><i>Correct order but no explanation of how they relate</i></p>

02/17/14

The insect visual cascade begins with the cis-retinal chromophore absorbing a photon of light. the absorption causes the cis-retinal to isomerize into trans-retinal, *these two are linked* as well as cause a confirmation change of opsin into metarhodopsin. In insects, this process is light-reversible. The presence of metarhodopsin causes G-Proteins, or guanine nucleotide binding proteins, to change from their inactive form as heterotrimer subunits that bind GDP, to their active state as alpha subunits that bind GTP. At this point, the photon is amplified in the visual cascade, as one molecule of metarhodopsin activates hundreds of G-Proteins. The activated G-Proteins activate Phospholipase C, a membrane-bound enzyme which breaks down PIP<sub>2</sub>, amembrane phospolipid, into inosine triphosphate (IP<sub>3</sub>) and diacyl glycerol (DAG). At this point, the Transient Receptor Potential is activated, but the mechanism as to how is still unknown. It is believed that TRP is activated by DAG in the cell membrane. This activation causes IP<sub>3</sub> to bind to receptors on the smooth endoplasmic reticulum, which then releases Ca<sup>2+</sup>. Once the Calcium is released, the TRP gated ion channels allow Na<sup>+</sup> and Ca<sup>2+</sup> into the cell, depolarizing the retinula cell membrane and if enough depolarization is achieved, an action potential is activated and sends information to the synapses, where it is relayed to the brain.

*Originally thought  
that this activated TRP  
channels, now think it is  
DAG acting more directly*



# ENTO 827 Paper 1 Score Sheet

Name: [REDACTED]

Total score: 19.5/20

**Question:** Describe, as fully as possible, the events that occur from a photon being absorbed by a rhodopsin molecule in a retinula cell to the generation of an action potential in an interneuron that synapses with the retinula cell. You should expect to integrate your knowledge from **more than one lecture** in your answer.

There are three major process that should be described: the visual cascade, generation and propagation of an action potential and transmission of the nerve signal across a synapse. A successful paper will describe each of these process in detail and demonstrate understanding of the sequence in which they occur and how they are related.

The descriptions of typical answers, given below, are guidelines, not checklists for assigning points

<p><b>Visual cascade</b></p> <p><i>Basic</i> (1 point) Mentioned but not described</p> <p><i>Intermediate</i> (3 points) Some details given but others are missing and/or details in incorrect order</p> <p><i>Advanced</i> (5 points) All steps described in detail and in correct order</p>	<p>5</p> <p>very good</p>
<p><b>Action Potential</b></p> <p><i>Basic</i> (1 point) Mentioned but not described</p> <p><i>Intermediate</i> (3 points) Some details given but others are missing and/or details in incorrect order</p> <p><i>Advanced</i> (5 points) All steps described in detail and in correct order</p>	<p>4.5</p> <p>Generally good, could use explanation of directional propagation</p>

<p><b>Synapse</b></p> <p><i>Basic</i> (1 point) Mentioned but not described</p> <p><i>Intermediate</i> (3 points) Some details given but others are missing and/or details in incorrect order</p> <p><i>Advanced</i> (5 points) All steps described in detail and in correct order</p>	<p>⑤</p> <p>Good</p>
<p><b>Sequence of / relationship between major processes</b></p> <p><i>Basic</i> (1 point) Major process mentioned but order incorrect and/or no understanding of relationship</p> <p><i>Intermediate</i> (3 points) Major processes in correct sequence, relationship partially described or some mistakes</p> <p><i>Advanced</i> (5 points) Major process in correct sequence, clear understanding of relationship</p>	<p>⑤</p> <p>You clearly understand how everything fits together</p>

19 February 2014

Ento 401

Paper 1

The ability to see surroundings is vital for the survival of many insects. To begin the process of visualization a photon must first enter in through one of the visual organs of an insect and reach the retinula cell. A photon of light hitting the retinula cell then triggers a domino effect of reactions and eventually a nerve impulse is sent to the optic lobe where the impulse is turned into an image.

A retinula cell neuron is most important for vision because of the presence of the visual pigment rhodopsin. Rhodopsin is found on the cell membrane of the microvilli that make up the rhabdomer of the retinula cell. There are two components of rhodopsin: retinal and opsin. Opsin is a transmembrane protein that has seven transmembrane domains. On the seventh domain of the opsin protein there is a very important chromophore bonded to a lysine amino acid called retinal. When the light hits the retinula cell of an insect and comes into contact with the retinal of the rhodopsin pigment the retinal changes from a cis-retinal to a trans-retinal, which in turn changes the conformation of the opsin protein. This new structure is called "metarhodopsin."

After the rhodopsin pigment has been changed to the ~~conformer~~ metarhodopsin, it can then activate a heterotrimer protein known as a G-protein, which is a guanine nucleotide binding protein. It has three parts, the  $\alpha$ ,  $\beta$ ,  $\gamma$  subunits. The inactive form of the G-protein has all three subunits together and binds GDP (guanosine diphosphate). The metarhodopsin is able to activate the G-protein to where it is only the  $\alpha$  subunit binding a GTP (guanosine triphosphate). In this step the signal created by a photon of light can be amplified because one metarhodopsin can



activate several hundred G-proteins. And metarhodopsin, unlike in humans, is light-reversible in insects.

After the G-protein has been activated it goes on to activate the enzyme Phospholipase C which is an enzyme that breaks down a specific phospholipid in the cell membrane called  $\text{PIP}_2$  (phosphatidyl inositol biphosphate).  $\text{PIP}_2$  is broken down into DAG (diacyl glycerol) which stays in the membrane, and  $\text{IP}_3$  (inosine triphosphate) which goes into the cytoplasm. The mechanism by which the next step happens is still unclear, but the DAG or  $\text{IP}_3$  activates the Transient Receptor Potential (TRP) channels which allow sodium ( $\text{Na}^+$ ) and calcium ( $\text{Ca}^{2+}$ ) ions to flow into the retinula cell and depolarize the cell enough for an action potential.

Action potential of the retinula cell takes place in a series of steps in the axon of the neuron. First, the  $\text{Na}^+$  and potassium ( $\text{K}^+$ ) move across the selectively permeable membrane of the retinula cell through voltage gated channels and depolarize the cell membrane by making it less negative inside the cell. The movement of these ions is so quick that there is a slight "over shot" that causes a rapid ball-and-chain mechanism to close the  $\text{Na}^+$  gated channels. The  $\text{K}^+$  then moves out of the cell along a concentration gradient which repolarizes the cell.

*$\text{K}^+$  does not move much during depolarisation (it is at equilibrium)*

*causes "refractory period" ensures directional propagation*

Once an action potential occurs in a retinula cell it is sent down the axon. When it reaches the end of the neuron it must then be transferred to the next neuron through a synapse. A synapse is composed of three parts, a pre-synaptic terminus, a synaptic cleft, and a post-synaptic terminus. When the action potential comes to the end of the axon where the pre-synaptic terminus is the voltage-gated  $\text{Ca}^{2+}$  ion channels open and  $\text{Ca}^{2+}$  enters the cell. This causes vesicles to fuse with the membrane of the pre-synaptic terminus. These vesicles release neurotransmitters into the synaptic cleft, a space between the two terminuses, which then diffuse and bind to the post-synaptic terminus to open the ligand-gated ion channels. The receptors then

*caused depolarization,  
which can lead to an action potential*

open and change the permeability of the post-synaptic terminus and creates an action potential once a certain threshold is reached. To prevent continuous action potentials being produced, the neurotransmitters are then degraded by enzymes that are specific to the neurotransmitter. An example of a neurotransmitter and its enzyme would be acetylcholine and acetylcholinesterase. The produced action potential will then travel down the dendrite of the new neuron.

This action potential is passed neuron to neuron until it reaches the optic lobe of the insect in the protocerebrum of the brain. There it is translated into an image. The entire process of a photon of light hitting a retinula cell and creating an action potential in the neuron seems to happen almost instantly, but there are several steps that must occur before an insect can witness its surroundings.

## ENTO 827 Project 1 Grading Rubric & Score Sheet

Name:

Total:

**Task:** Design a lab for a 100-level class that illustrates an aspect of the endocrine system's role in regulating insect development. If necessary, your lab may extend over more than one class period (e.g. set up one week, collect results in a different week). Write a short document (1,000 words maximum) describing your lab. Your document should include.

- An explanation of the effect of the endocrine system that your lab illustrates.
- A description of the procedures to be used in the lab
- The expected results and an explanation of how these results illustrate the effect of interest.

Keep in mind that the procedures for the lab should be appropriate for the skills that could be reasonably be expected of undergraduates taking a 100-level class and the resources that would be available to such a class.

The descriptions of typical answers, given below, are guidelines, not checklists for assigning points

### **Scientific accuracy**

*How well is the effect or principle that is the subject of the lab explained?*

Basic (1 point): Explanation is present but there are significant inaccuracies

Intermediate (3 points): Explanation mostly correct but some mistakes

Advanced (5 points): Explanation is clear, complete and accurate

<p><b>Effectiveness of proposed lab</b>  <i>How well does the proposed lab illustrate the subject?</i></p> <p><u>Basic (1 point):</u> Proposed lab relates to the subject effect but would not provide a clear demonstration</p> <p><u>Intermediate (3 points):</u> Proposed lab demonstrates the subject effect but there are potential confounding effects or alternative interpretations</p> <p><u>Advanced (5 points):</u> Proposed lab demonstrates the subject effect in a clear and unambiguous manner</p>	
<p><b>Procedures</b>  <i>Are the proposed procedures well described and feasible?</i></p> <p><u>Basic (1 point):</u> Procedures are not clearly described or would require unrealistic skill levels, equipment or materials.</p> <p><u>Intermediate (3 points):</u> Procedures are described but some areas of ambiguity or procedures would be challenging but not impossible</p> <p><u>Advanced (5 points):</u> Procedures are clearly described and feasible</p>	
<p><b>Results</b>  <i>Are the expected results clearly described and related to the subject effect?</i></p> <p><u>Basic (1 point):</u> Cursory description, not related to subject of the lab</p> <p><u>Intermediate (3 points):</u> Expected results are described and related to the subject of the lab, some mistakes.</p> <p><u>Advanced (5 points):</u> Expected results are described clearly and accurately. How the results demonstrate the subject of the lab is clearly explained.</p>	



# ENTO 827 Project 1 Grading Rubric & Score Sheet

Name: [REDACTED]

Total: 14/20

**Task:** Design a lab for a 100-level class that illustrates an aspect of the endocrine system's role in regulating insect development. If necessary, your lab may extend over more than one class period (e.g. set up one week, collect results in a different week). Write a short document (1,000 words maximum) describing your lab. Your document should include.

- An explanation of the effect of the endocrine system that your lab illustrates.
- A description of the procedures to be used in the lab
- The expected results and an explanation of how these results illustrate the effect of interest.

Keep in mind that the procedures for the lab should be appropriate for the skills that could be reasonably be expected of undergraduates taking a 100-level class and the resources that would be available to such a class.

The descriptions of typical answers, given below, are guidelines, not checklists for assigning points

## Scientific accuracy

How well is the effect or principle that is the subject of the lab explained?

Basic (1 point): Explanation is present but there are significant inaccuracies

Intermediate (3 points): Explanation mostly correct but some mistakes

Advanced (5 points): Explanation is clear, complete and accurate

(3)

Appears to be some confusion here. Removing the head can prevent molting because PTTH is made in the brain and PTTH is needed to stimulate ecdysone production in the prothoracic gland

PTTH & ecdysone control when molting will happen

JH controls the outcome of molting

Discussion of JH in the context of this experiment is distracting

<p><b>Effectiveness of proposed lab</b>  <i>How well does the proposed lab illustrate the subject?</i></p> <p><u>Basic (1 point):</u> Proposed lab relates to the subject effect but would not provide a clear demonstration</p> <p><u>Intermediate (3 points):</u> Proposed lab demonstrates the subject effect but there are potential confounding effects or alternative interpretations</p> <p><u>Advanced (5 points):</u> Proposed lab demonstrates the subject effect in a clear and unambiguous manner</p>	<p>③</p> <p><i>This lab would be effective at demonstrating</i>  <i>a) the role of the head in regulating molting</i>  <i>b) the existence of a critical period</i>  <i>But it would not illustrate anything to do with JH or ecdysone</i></p>
<p><b>Procedures</b>  <i>Are the proposed procedures well described and feasible?</i></p> <p><u>Basic (1 point):</u> Procedures are not clearly described or would require unrealistic skill levels, equipment or materials.</p> <p><u>Intermediate (3 points):</u> Procedures are described but some areas of ambiguity or procedures would be challenging but not impossible</p> <p><u>Advanced (5 points):</u> Procedures are clearly described and feasible</p>	<p>⑤</p> <p><i>Experimental procedures straightforward and clearly described</i></p>
<p><b>Results</b>  <i>Are the expected results clearly described and related to the subject effect?</i></p> <p><u>Basic (1 point):</u> cursory description, not related to subject of the lab</p> <p><u>Intermediate (3 points):</u> Expected results are described and related to the subject of the lab, some mistakes.</p> <p><u>Advanced (5 points):</u> Expected results are described clearly and accurately. How the results demonstrate the subject of the lab is clearly explained.</p>	<p>③</p> <p><i>Results are described but the explanation lies in the relationship between the brain &amp; PTTH / ecdysone &amp; the prothoracic gland</i>  <i>not ecdysone &amp; JH</i></p>



ENTO 401  
Dr. Miller  
17 March 2014

### Project 1: Endocrine System and Insect Development Lab

The purpose of this lab is to demonstrate the importance of the hormones in the kissing bug, or scientifically, *Rhodnius prolixus*, in development into an adult. The lab will show students that the head of an insect is not totally necessary in development from the fifth instar to an adult. As we know already the ability for an insect to become an adult is through the use of hormones, one of the prominent hormones being juvenile hormone (JHIII). The amount of juvenile hormone in the insects system determines whether the insect will molt to be another immature or become an adult during molting, and with each successive molt the amount of juvenile hormone is decreased. If the juvenile hormone levels are not decreased the insect will not continue into pupation. While in the last instar a kissing bug's head can be removed after about a week after feeding and the insect will still continue to molt into an adult. If the head is removed before that week period after feeding the insect will fail to molt into an adult. This is due to hormones that control insect development produced in the brain. In the absence of juvenile hormone, if another hormone, ecdysone, reaches a critical concentration the insect will finally develop into an adult, but if the concentration is not high enough the insect will continue to develop into another immature. If the brain is removed before the concentration is high enough, the insect will fail to molt into an adult, and if the head is removed later in the instar the concentration is high enough that the head is no longer needed by the insect to develop into an adult.

*g ecdysone? No, not enough ecdysone → no molt*

*It will fail to molt altogether*

Students should have a simple understanding of the hormones used in insect development before proceeding into completing the lab. The procedure for this lab is quite simple and should

only take about two lab periods. The first lab period the students will receive a kissing bug in it's last instar that had fed about three, five, seven or nine days before. Each student will only have one insect and the class will compare the results together as a group. The students will be told which insect they have and will make a hypothesis whether the insect will pupate into an adult or not. Then students will remove the head of their insect with a sharp instrument, like a scalpel. Students will then place their decapitated insects into labeled containers to be looked at during the next lab period.

After a week has passed, the students will check on their insects and observe their results. Hopefully all of the insects have gone through a molt whether to adult or not and the students can chart the classes results. If some of the insects had not had enough time to molt, another week may be needed to allow those insects to give results for the class.

The results for this lab should be straightforward. Insects that had fed three, five, and possibly seven days previously should not molt into adults while insects that fed seven and nine days previously should have molted into adults. The reason the insects that had fed seven and nine days before having their head removed is because in those seven to nine days the insect was able to produce a sufficient quantity of ecdysone, that in the absence of juvenile hormone allows the insect to pupate and develop into an adult. Those insects that did not molt into adults after their heads were removed can be explained because the insect did not have enough ecdysone in their system, in the absence of juvenile hormone, to molt into adults.

With these results, students should be able to see the importance of the endocrine systems and its role in insect development. The development of these insects is due to the various concentrations of certain hormones found in the hemolymph of the insects. The experiment



proves that by showing the students that the insect does not need it's head once there is enough ecdysone in the insect to trigger a molt to develop into an adult.

# ENTO 827 Project 1 Grading Rubric & Score Sheet

Name: [REDACTED]

Total: 20/20

**Task:** Design a lab for a 100-level class that illustrates an aspect of the endocrine system's role in regulating insect development. If necessary, your lab may extend over more than one class period (e.g. set up one week, collect results in a different week). Write a short document (1,000 words maximum) describing your lab. Your document should include.

- An explanation of the effect of the endocrine system that your lab illustrates.
- A description of the procedures to be used in the lab
- The expected results and an explanation of how these results illustrate the effect of interest.

Keep in mind that the procedures for the lab should be appropriate for the skills that could be reasonably be expected of undergraduates taking a 100-level class and the resources that would be available to such a class.

The descriptions of typical answers, given below, are guidelines, not checklists for assigning points

## Scientific accuracy

*How well is the effect or principle that is the subject of the lab explained?*

Basic (1 point): Explanation is present but there are significant inaccuracies

Intermediate (3 points): Explanation mostly correct but some mistakes

Advanced (5 points): Explanation is clear, complete and accurate

⑤

All clearly explained

Did you know why JH extends the duration of the 5<sup>th</sup> larval stage? It is because JH inhibits PTTH production in some legs

<p><b>Effectiveness of proposed lab</b>  <i>How well does the proposed lab illustrate the subject?</i></p> <p><u>Basic (1 point):</u> Proposed lab relates to the subject effect but would not provide a clear demonstration</p> <p><u>Intermediate (3 points):</u> Proposed lab demonstrates the subject effect but there are potential confounding effects or alternative interpretations</p> <p><u>Advanced (5 points):</u> Proposed lab demonstrates the subject effect in a clear and unambiguous manner</p>	<p>(5)</p> <p><i>This lab should clearly demonstrate the effect of JH. Weighing larvae is a good idea: it will help show the delayed molt is not due to a general slow down in growth &amp; development</i></p>
<p><b>Procedures</b>  <i>Are the proposed procedures well described and feasible?</i></p> <p><u>Basic (1 point):</u> Procedures are not clearly described or would require unrealistic skill levels, equipment or materials.</p> <p><u>Intermediate (3 points):</u> Procedures are described but some areas of ambiguity or procedures would be challenging but not impossible</p> <p><u>Advanced (5 points):</u> Procedures are clearly described and feasible</p>	<p><i>Procedures all straightforward and well described</i></p> <p>(5)</p>
<p><b>Results</b>  <i>Are the expected results clearly described and related to the subject effect?</i></p> <p><u>Basic (1 point):</u> Cursory description, not related to subject of the lab</p> <p><u>Intermediate (3 points):</u> Expected results are described and related to the subject of the lab, some mistakes.</p> <p><u>Advanced (5 points):</u> Expected results are described clearly and accurately. How the results demonstrate the subject of the lab is clearly explained.</p>	<p>(5)</p> <p><i>Expected results clearly described and related to role of JH</i></p>

## **Endocrine System's Role In Insect Development**

This experiment will focus on the effect of juvenile hormone on insect molting and larval development. Juvenile hormone functions as an insect growth regulator, controlling larval development and metamorphosis. Juvenile hormone is released by a pair of endocrine glands that are located behind the brain, called the corpora allata. JH is found in the hemolymph of the immature insect. As the insect gets older and goes through subsequent molts the amount of JH in the hemolymph decreases with each molt. When juvenile hormone is very low or completely depleted this will trigger the insect to go into the pupal stage of metamorphosis. In this experiment we will artificially increase the amount of juvenile hormone in the fifth instar larval stage of the hawk moth (*Manduca sexta*). The fifth instar of *Manduca sexta* will be exposed to various treatments of the chemical Methoprene. Methoprene is described as having the same effects as juvenile hormone in insect development. It will allow us to simulate the presence of additional juvenile hormone late in the insect development stages. Since juvenile hormone regulates the length of instars, we should see an increase in the length of the fifth instar stage.

### **Procedures**

This experiment will use the hawk moth larvae of *Manduca sexta* as the test subject. The hawk moth larvae will be reared in the lab prior to the experiment date. They will be reared under controlled temperature, humidity, and photo-period. Larva will be fed a dietary substrate of wheat germ throughout their instars.

Week one of the experiment the students will be supplied in lab with four *Manduca sexta* larvae. The larvae will have just molted into the fifth instar one to two days before the start of the experiment. The students will topically apply three different concentrations of the Methoprene treatment. The fourth larvae will be used as the control. The students will use a syringe to topically apply 0, 5, 10, 20 ng a.i. of Methoprene, diluted in 5ml of ethanol solvent. These doses will be measured in advance, diluted and labeled by the instructor to ensure accuracy and reduce exposure of the chemical to the students. The control will only receive the 5ml ethanol solvent with no Methoprene added. Students will be instructed to apply the liquid treatment behind the head capsule of the larvae directly to the insects integument. Specimens will be left in the lab under constant conditions.

The students will have to come in throughout the week to monitor how many days each larvae has been in the fifth instar. The second week of the experiment students will observe the progress of the larvae and note any changes to the larvae. Students will collect final results the third week. Students should at least be able to see a difference between the control compared to the highest dose of Methoprene treatment to the fifth instar.

### **Results**

The application of Methoprene should extend the fifth instar of the larval stage by a noticeable margin and postpone pupation. The extension of the larval instar is expected to correlate with the dosages of Methoprene. Thus the largest dose of 20 ng a.i. of Methoprene dissolved in ethanol should result in the longest instar period of all four larvae documented. The fifth instar stage is expected to be lengthened by 5-12 days compared to the control larvae. Unusually high doses are expected to induce a stage of permanent larvae, where the larvae fails to pupate entirely. Since the fifth instar is



considerably lengthened, there should be a noticeable amount of weight gain because of the extended feeding period. These results will show that juvenile hormone simulated by the use of Methoprene lengthens the amount of time the larvae spends in the immature stage of its metamorphosis cycle. Since juvenile hormone plays a major role in the control of larval development and metamorphosis, an addition of JH late in the life cycle of *M.sexsta* will result in an abnormally long fifth instar stage. Normally in the fifth instar juvenile hormone is very low in the insect hemolymph and this allows the insect to advance into the pupal stage of metamorphosis. Instead, by adding high amounts of juvenile hormone to the fifth instar we are altering the natural amount of juvenile hormone in the insect's body. We have tricked it into remaining in the larval stage for a longer amount of time.

## **ENTO 401 Presentations Reviewing / Grading Guide**

### **Timing (5 points)**

10 minutes are available for the presentation. Was the time used effectively?

0            Poor, did not complete in 10 mins or finished in under 7 mins

1

2

Reasonable, completed on time but had to rush

3

4

5            Excellent, completed without rushing in 9 - 10 mins

### **Overall Quality of Presentation (5 points)**

Was the oral part of the presentation well practiced? Were slides well presented and easy to understand?

0            Very poor, presentation incoherent, slides incomprehensible

1

2

Reasonable, some problems with oral presentation, slides serviceable but hard to understand

3

4

5            Excellent, well rehearsed presentation and clear slides

### **Presenter's Understanding of the Paper (5 points)**

Did the presenter have a clear understanding of the paper they were presenting?

- 0            Presenter completely misunderstood the paper
- 1
- 2
- 3            Presenter mostly understood the paper but some gaps or errors.
- 4
- 5            Presenter clearly understood the rationale, methods and results of the paper

### **Presentation of Background to the Paper (5 points).**

The background to a paper, given in the Introduction explains the rationale for a paper i.e. why was the research worth doing and why was the approach taken appropriate. How well was this explained in the presentation?

- 0            Very poor no background provided
- 1
- 2
- 3            Background provided but some problems, e.g. motivation for the research unclear
- 4
- 5            Excellent, background clearly summarized



### **Identification of Hypothesis (5 points).**

Experimental research involves the testing of hypotheses. Did the presenter identify the hypothesis / hypotheses that the authors of the paper tested?

- 0        No hypothesis identified
- 1
- 2
- 3        Attempt made but some problems, e.g. presenter misunderstood the hypothesis
- 4
- 5        Yes, hypothesis identified

### **Articulation of Hypothesis (5 points).**

How effective was the presenter at articulating the hypothesis / hypotheses that they identified?

- 0        Ineffective, presenter did not describe the hypothesis
- 1
- 2
- 3        Reasonable but some problems e.g. hypothesis described but presenter not easy to understand
- 4
- 5        Excellent, hypothesis clearly described / explained

### **Presentation of Methods (5 points).**

Testing a hypothesis involves conducting experiments to see if the predictions that stem from the hypothesis hold up. How well were the experimental methods described?

- |   |  |
|---|--|
| 0 | Poor, no description of methods  |
| 1 |  |
| 2 |  |
| 3 | Reasonable but some problems, e.g. methods not clear, excessive detail, not related to predictions of hypothesis |
| 4 |  |
| 5 | Excellent, methods clearly described and related to the predictions of the hypothesis                            |

### **Presentation of Results (5 points).**

Were the results of the experiments clearly described?

- |   |  |
|---|--|
| 0 | Results not described  |
| 1 |  |
| 2 |  |
| 3 | Reasonable but some problems, e.g. confusing or excessively detailed |
| 4 |  |
| 5 | Excellent, results clearly described / summarized                    |

**Presentation of Conclusions (5 points).**

What may be concluded from the results of the experiment? Do the results support or refute the hypothesis?

- 0        No conclusions presented
- 1
- 2        Conclusions presented but some problems, e.g. confusing or incomplete presentation
- 3
- 4
- 5        Clear conclusions made in relation to hypothesis

**Presentation of Implications (5 points).**

What are the wider implications of this research? What does it tell us about insect biology & physiology in general?

- 0        No implications presented
- 1
- 2        Attempt made but confusing or incomplete.
- 3
- 4
- 5        Excellent, implications clearly presented

## Hypothesis

- The method of JH regulation in Bees is unknown.
- How is JH regulated so that the plasticity in job structure is able to be part of hive physiology?
- If measured and analyzed the corpora allata should give insight.

# Hypothesis

- They hypothesized that an injection of 5-HT into the brain and the abdomen would cause a reduction in food consumption because of previous studies that measured the effects of serotonin on other insects.